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ABSTRACT

A visit to a maple sugar bush has become a traditional springtime ritual for many school classes in northern areas. The sensations and experiences from this early springtime activity can be used for a number of study areas, including science, mathematics, art, social studies, home economics, language arts and health. This document provides learning activities for each of these areas that can grow out of students' study of maple sugar production. A number of specific maple syrup-related activities are also included. Children may learn to identify the different species of trees, measure the circumference of sugar maples to determine the number of holes to be drilled for taps, and participate in the actual tapping of a tree. They may also learn how to measure sap flow and record it on charts for each tree; with graphs they record the effects of factors influencing sap flow such as temperature, weather conditions, size and location of trees and heights of the tapholes from the ground. Through the use of the Hydrometer method students learn to measure the sugar content of the sap. A number of recipes for cookies, cakes, and other maple "goodies" are given, and work with them would provide practice in the use of metric measurements. In addition to all types of learning activities, this book provides teacher background information in such areas as the historical background of maple sugar production and methods by which sap is collected and syrup and sugar produced. (LS)

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The Sweet Taste of Spring

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F O R E W O R D

This booklet is provided to assist teachers in developing an integrated approach to the study of maple syrup production. A visit to a sugar bush has become a traditional springtime ritual for school classes, and excitement runs high with a feeling of spring in the air. Use this booklet as a guide for exploring new avenues of learning which capitalize on the sensations and experiences of this early springtime adventure.

Written and edited by Heather Jones and Rodger Bullock
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POEMS:

Maple Syrup Time

Did you ever have a party,
In the days of long ago,
Away back in the forest
Where the sugar-maples grow?

If you have, you know the pleasure
That in "sugaring-off" is found,
As you stir the maple sweetness
Round and 'round, 'round and 'round.

You know, life's a lot like maple sugar-
Weak, insipid at the start,
But the fires of time and trouble
Find the sweetness at the heart.

What's true of maple sugar
May be true of you and me!
The more we are fired and beaten
The finer-grained we'll be!

- Evelyn R. Cheney (1845)

Maple Syrup Time

Soon the blue birds and the bees
O'er the stubble will be winging;
So 'tis time to tap the trees
And to set the axes a ringing;

Time to set the hut to rights,
When the girls and boys together
Tend the furnace fire o' nights
In the rough and rainy weather;

Time to hew and shape the trough,
And to punch the spile so hollow,
For the snow is thawing off
And the sugar-thaw must follow,

Oh, the gladdest time of year
Is the merry sugar-making,
When the swallows first appear
And the sleepy birds are waking!

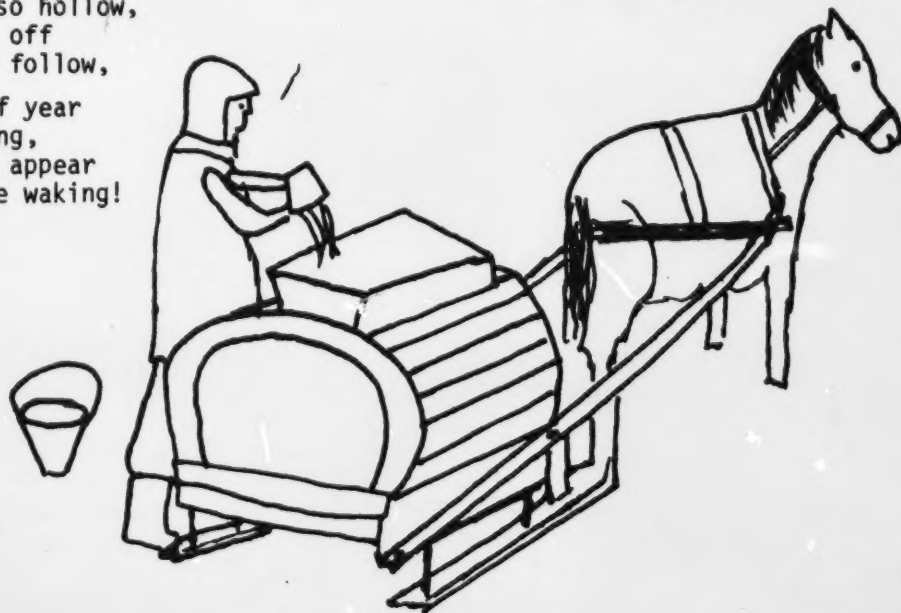
(1) Maple Sugar Making

When the snows of winter are melting fast,
And the sap begins to rise,
And the biting breath of the frozen blast
Yields to the Spring's soft sighs,
Then away to the wood,
For the maple, good,
Shall unlock its honied store:
And boys and girls
With their sunny curls
Bring their vessels brimming o'er
With the luscious flood
Of the brave tree's blood,
Into cauldrons deep to pour.

(11)

The blaze from the sugar-bush gleams red;
Far down in the forest dark,
A ruddy glow on the tree is shed,
That lights up the rugged bark;
And with merry shout
The busy rout
Watch the sap as it bubbles high;
And they talk of the cheer
Of the coming year,
And the jest and the song pass by;
And brave tales of old
Round the fires are told
That kindles youth's beaming eye.

- Susanna Moodie
The Maple Tree



Long before the coming of the white settlers to North America, the Indians, in the spring, gathered the highly prized "sugar water". Sugaring off provided not only their sole source of sugar but also a time for the entire family to share responsibilities in this festive occasion. Each family gathered in its own sugar bush with the women assuming control of the operation. The squaws gashed the trees, collected and boiled the sap, while the braves watched the activity and sampled the product. The finished product was packaged in white birch containers called "mukuks", The "mukuks" held 9 to 32 kilograms of sugar, some of which was for personal use and the rest for trading with other tribes. The average camp produced between 135 and 180 kilograms of sugar.

The sugar process, although primitive, served the purposes of the Indians. First the squaws gashed the maple tree in a slanting direction with a tomahawk. Then a reed or piece of grooved wood was inserted to channel the flow of the sap. This liquid was caught in a trough (hollowed log) or a birch bark container resting on the ground. The Indians employed two methods of boiling the sap:

- 1) The sap was placed in an earthen vessel which was set on a bed of hot coals.
- 2) Hot stones were dropped into the vessel containing the sap until the desired consistency was achieved.

This method produced a dark, smokey tasting syrup with impurities.

Candy was often made for the children by pouring the syrup into larger "mukuks" to harden.

Quite often this sugar was sold to the white men for "squaw money" or "pretty money", in exchange for trade goods.

White settlers around 1600

The Jesuit missionaries were the first white men to record the maple sugaring activities of the Indians. The Indians collected the "maple water" from the "Mickton" or maple tree and the finished product was welcomed by these early missionaries.

The early settlers quickly adopted and improved the techniques developed by the Indians. Because sugar, made from cane or beets, was scarce and expensive, every farmer devoted the spring to the making of maple sugar.

The production of maple sugar in North York and other areas of Ontario and Quebec is outlined in the following paragraphs:

Each farmer cleared his bush of underbrush, fallen trees and rotten logs. The bush was fenced to prevent the cattle from upsetting the troughs and drinking the sap (which could prove fatal to them). The boiling centre was located in the middle of the bush with roads radiating outward so that the ox sleds could be used to bring in the sap. The collected sap was stored in hollowed logs, some up to 100 pail capacity.

Gashing one tree gave way to tapping with the use of an auger. The hole was slanted upwards, $2\frac{1}{2}$ cm - 4 cm deep into the tree into which a wooden spile was inserted. Troughs made of pine, black ash, cherry or butternut were placed on the ground under the spile to catch the dripping sap. The sap was poured into containers and hauled by oren to the boiling centre where the sap was stored in large troughs. The boiling kettles (Iron or copper), purified by

using liquor, were hung over a fire which was kept burning both day and night. When the sap was boiled to a consistency of thin molasses it was clarified by adding beaten eggs or milk. The eggs floated to the top trapping the impurities with it. The kettle was then removed from the fire and the layer of eggs and impurities were skimmed off leaving a bright, clear liquid which was then boiled down to sugar.

Before pouring it into molds, the boiled syrup was tested by dropping a little on the snow. If it hardened quickly it was ready to pour into the waiting molds.

Often as much time was spent in decorating the molds as in making maple sugar.

The early part of the season was devoted to the making of maple sugar, however, as spring neared its end, the sap became acid. This high acidity sap was used to make vinegar and beer. (See recipe section for method). When the season was over, the spiles were removed and the hole sealed with a piece of wood or by other means.

The Manufacture of Maple Products

Although maple sugar and syrup can be made using the sap from any member of the Maple tree family, the "sugar" or "hard rock maple" and the black maple are the most popular. Of the two the sugar maple has the highest sugar content making it the most desirable tree to tap.

The sugar maple is a long living, slow growing tree, characterized by a medium sized lobed leaf and gray plated bark. The black maple has a smaller leaf but similar bark.

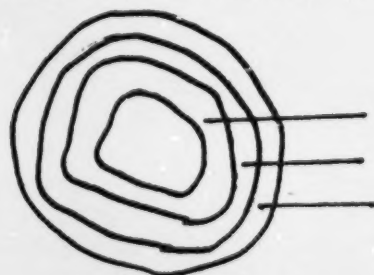
BLACK
MAPLE



SUGAR
MAPLE



During the summer months Nature is busy making next spring's maple crop. The action of sunlight on the chlorophyll of the leaves makes sugar which is stored in the tree until dissolved by the sap the following spring.



Sap Wood
Inner Bark
Outer Bark

The amount of sap which can be gathered from a tree depends upon the following:

- 1) The size, condition of the tree, and crown area,
- 2) The condition of the forest floor,
- 3) The weather.

Under favourable conditions an average seasonal yield of 55 to 80 litres per tree is not uncommon. With a sugar content varying between 2 to 3 percent this would yield from $1\frac{1}{2}$ to 2 kilograms of sugar or 1 to $1\frac{1}{2}$ litres of

syrup per tree per season. It takes between 35 to 40 litres of sap to produce one litre of maple syrup. The rest of the sap is water which is boiled away in the evaporating process.

As was mentioned earlier, one of the conditions influencing the flow of sap is the weather. Ideal conditions would be warm, sunny days (3°C), with a light freezing night. The clear sap runs slowly, a drop at a time, and tastes like sweetened water.

Towards the end of April the weather is usually warm enough to encourage the maple buds to swell. Once this happens the chemistry of the maple tree changes and the sap becomes cloudy. This sap is undesirable as it produces a syrup with a "buddy taste". This terminates the sugaring until next year.

Selection and Tapping of Trees

The trees selected should exceed 25 cm. in diameter at breast height. The following table indicates the number of buckets which can be hung from trees of varying sizes.

TREES	25 cm - 40 cm diameter	yield - 1 bucket
	40 cm - 50 cm	" - 2 "
	50 cm - 60 cm	" - 3 "
	60 cm plus	" - 4 "

The trees are usually tapped in late February or early March, depending upon the weather. The holes should be from 90 to 120 cm. above the ground and at least 25 cm from previous visible holes. The hole is drilled at a slight upward angle using a sharp 1 cm bit and not more than $2\frac{1}{2}$ - 4 centimetres deep. The hole is then cleaned of shavings and a "flomore pill" inserted. The pill reduces the possibility of infection by bacteria or fungus while it prevents clotting. The spile is then gently inserted using a wooden or rubber mallet. Buckets, with covers, are hung on the spiles. The covers help reduce the possibility of foreign matter getting into the collected sap.



In larger operations plastic tubing links the spile and the sugar shack, greatly reducing the labour involved in collecting the sap.

The three prerequisites to the manufacture of high quality maple syrup are: cleanliness, speed and regularity. These must be applied to all phases of the maple sugar operation from collecting the sap to canning the syrup.

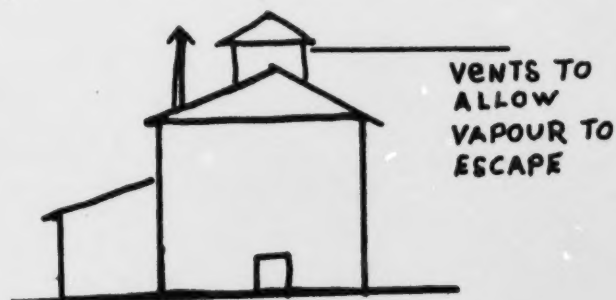
The sap should be collected frequently and processed as soon as possible if a high quality syrup is to be achieved. Sap gathered and processed early in the season makes the best syrup. As the season wears on the quality of syrup produced deteriorates.

When the buds on the trees begin to swell, the sap takes on a milky colour and is unfit for syrup. When this occurs the spiles are removed, the hole

scraped clean (remove flomore pill) and plugged with a cork.

Trees which are tapped carefully are not injured by the process and the holes should heal in 3 to 4 years.

The "Sugar House"



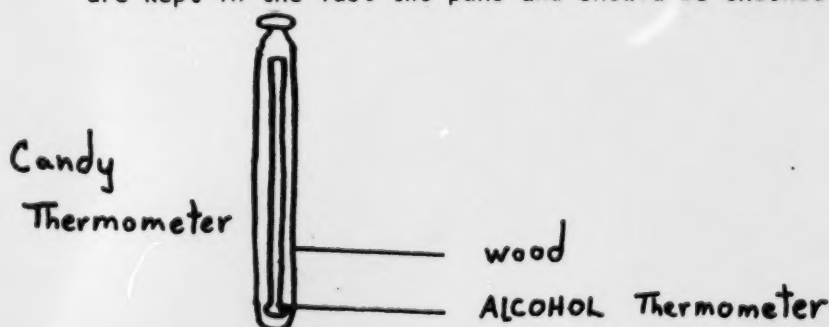
The collected sap is taken to the sugar shack where it is poured in holding or storage tanks. The modern evaporator has greatly facilitated the production of maple syrup.

The sap is filtered as it is poured into the holding tanks to remove the larger impurities. The sap then flows to either a pre-heating tank (found in larger operations) or directly to the evaporator (the pre-heating tank speeds up the evaporation process).

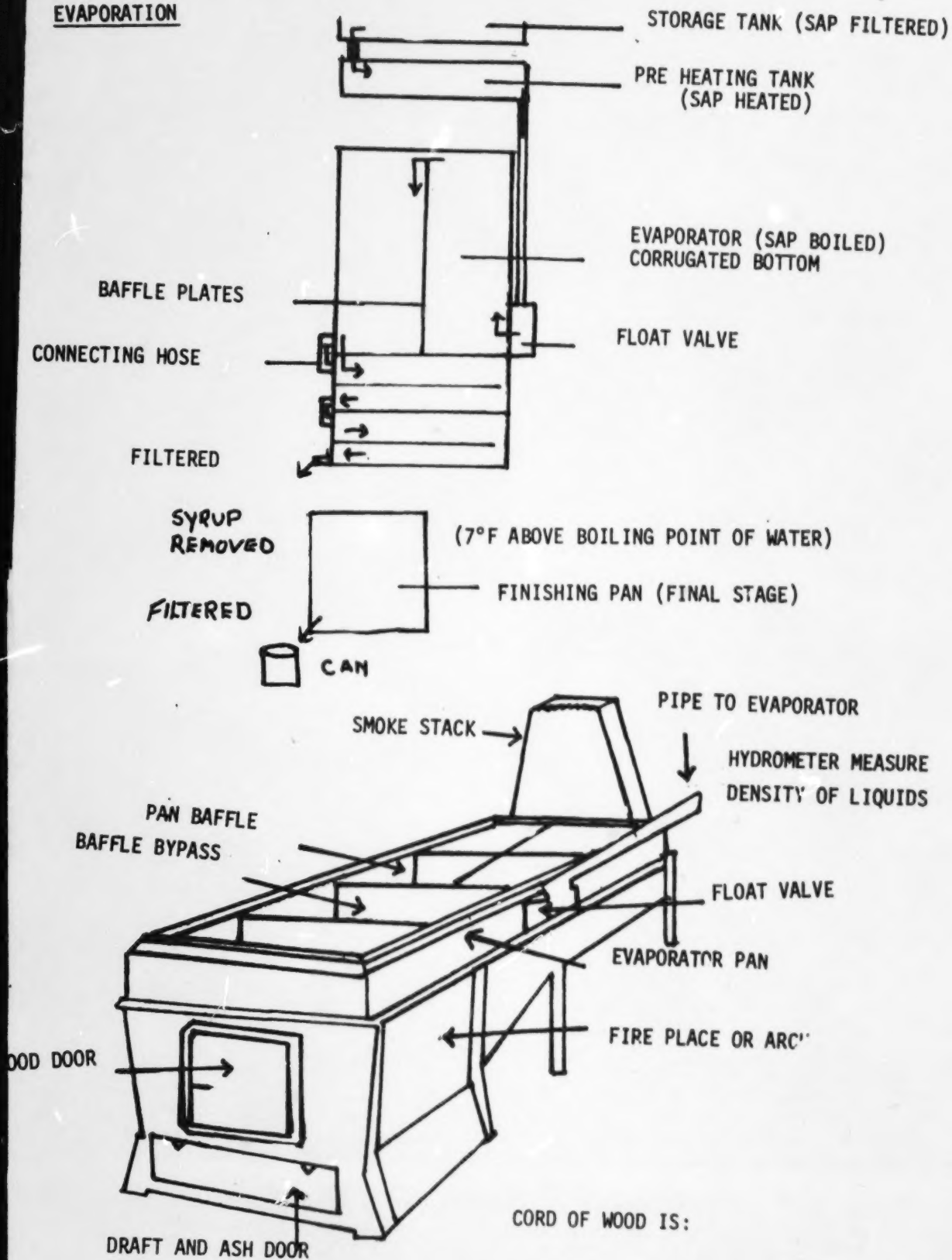
The flow to the evaporator is regulated by means of a float valve which is set to maintain a level of between 5 - 8 cm. of sap in the evaporator.

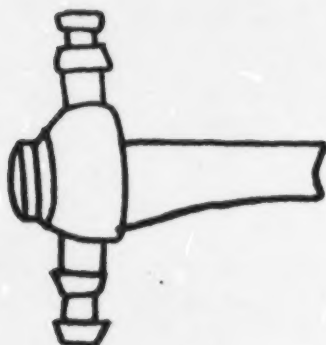
The evaporator is designed in such a manner as to reduce the possibility of the sap mixing with the thickening syrup by means of carefully arranged baffle plates. The evaporator consists of three pans, one large boiling pan (stainless steel bottom) and two smaller finishing pans (copper bottom). The sap enters the evaporator from either a pre-heating tank (larger operations) or the storage tank through the float valve. The sap is raised to the boiling point of water, and travels through the pans in a zig-zag fashion, passing into each section through openings cut into the bottom of each baffle plate and from pan to pan by connecting hoses fastened to openings at the bottom of each pan. When the boiling liquid reaches the front pan it has changed from a watery clear liquid to a light brown and thicker liquid.

The evaporating process requires constant vigilance to avoid "over-cooking" the syrup or burning the pans. The syrup can be drawn off when its temperature reaches 2°C above the boiling point of water. Candy thermometers are kept in the last two pans and should be checked constantly.



Because the temperature of boiling water varies with the altitude and weather conditions it should be checked daily to insure an accurately established drawing-off temperature. (If water boils at 100°C then the syrup will be drawn off at 102°C .)

EVAPORATION



PLASTIC SPOUT

CAST ALUMINUM SPOUT OR SPILE
(Driven into 9 mm hole-gently
as to not split bark).

SAP BUCKET

MAPLE SUGAR 115°c
 TAFFY 114°c
 MAPLE SYRUP 103°c
 SAP BOILS AT 100°c



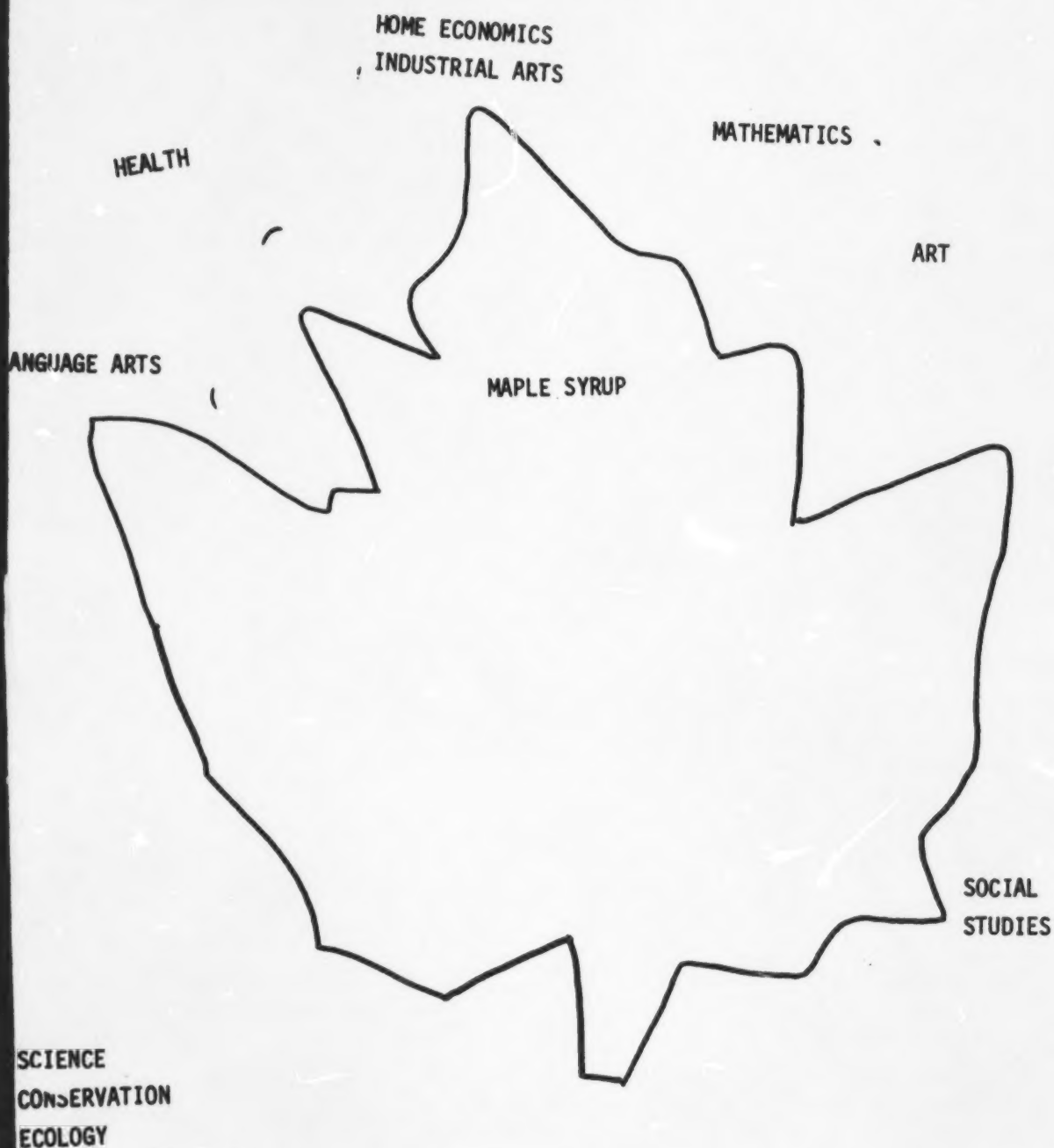
The drawn syrup is filtered through a clean felt filter to remove malate of lime commonly called nitre or "sugar sand". The filters used should be cleaned regularly and soaked in the sap before they are used.

The filtered syrup should be poured into sterile air-tight containers while hot. Syrup drawn at 3 degrees c above the boiling point of water will weigh about 1.3 kilograms to the litre and contain 65% of solids. Syrup of this density will not ferment if stored properly. The chart below indicates the temperatures at which the syrup should be drawn off for hard or soft maple sugar.

Soft sugar	11 degrees c	-	16 degrees c	ABOVE BOILING POINT OF WATER
Hard sugar	17 degrees c	-	21 degrees c	" " " " "

The final boiling stage is usually done in gas heated finishing pans.

Besides maple syrup and maply sugar, other valuable products are made from maple sap - maple butter, maple cream and maple wax. In each case the cyrup is boiled until it reaches a temperature of 10 degrees c to 12 degrees c above the boiling point of water. To make maple butter, allow the syrup to cool to room temperature, then stir until crystallization commences. It is then poured into containers. To make maple cream is similar, however, the crystallizing product is beaten until quite stiff. It is then placed in suitable moulds. Maple cream should be used within a short period of time, otherwise it becomes quite hard. Maple wax is made by pouring the thick boiling syrup into suitable containers and allowing it to cool without any disturbance. After setting, the containers should be covered.



"GENERAL PROGRAM IDEA".

SCIENCE

- Develop a management program for a sugar bush (some considerations might be; care of trees, condition of forest floor, covering on the forest floor, culling, reforestation).
- study of weather - how weather affects the flow of maple sap (this could lead into a detailed study of weather, maps, symbols, interpretation of weather maps, setting up and operating a weather station).
- tree identification - introduction of a tree key, how to construct, use or interpret tree keys.
- vegetation profiles of a sugar bush area (types of vegetation, location as related to drainage).
- anatomy of a tree; - parts, age, growth patterns, health.
- photosynthesis
- water cycle - osmosis
- evaporation - experiments using sugared water
- chemical composition of sap, syrup
- compare natural maple syrup and artificial syrup for chemical composition, color, density, taste
- soil profiles - of a sugar bush
 - could be compared to open areas
 - study of humus; soil production, etc.

MATHEMATICS

- measuring and comparing
 - a) circumferences of trees
 - b) heights of trees
 - c) diameters of trees
 - d) population count of a specified area
- measuring capacity of pails, tank, maple syrup cans
- measuring the rate of flow, amount of flow over a period of time - this could be done on a daily basis with the results shown graphically
- determining the boiling point of water, sugar water (water experiments should be done over a period of time and during a variety of weather conditions)
- measuring distance from pails to shack - calculate total distance walked or for amount of plastic tubing needed
- Mass of sap, syrup, water (i.e. litre of each)
- discussion of liquid and dry measurement
- counting activities (trees, pails, etc.)
- price studies - maple syrup, artificial syrups (price and quantity)

ART

- scale models of sugar bush, hut, etc.
- sketching - maple bush, sugar operation
- bark rubbings
- picture stones
- diaramas of the operation
- carving sugar moulds (plasticine, clay, soft wood)
- photography - recording each step of a maple sugar operation

SOCIAL STUDIES

- history of maple sugar - Indians, missionaries, pioneers, modern times
- visits to different sugar bushes - compare operation and production methods
- experiment with pioneer living
- examine a sugar operation - examine all steps - introduce labour saving methods where possible
- mapping the sugar bush
- marketing maple syrup - advertising, packaging, organizing a company (students form a "Maple Syrup Company") delivering the product, etc.

HOME ECONOMICS

- preparing dishes using maple syrup
- pioneer dress (design and make their own)
- preparing the many products associated with the "maple syrup operation".
- having a "pancake and maple syrup" festival

LANGUAGE ARTS

- making movies, taking pictures (with or without cameras)
- dramatic interpretations (past and present of the event)
- stories (verbal, written, acted)
- sensory awareness (wind, feeling bark, touching forest floor, tasting sap, smells in the sugar shack)
- "inner feelings of a tree" - i.e. How would you feel to be a maple tree and have someone tap you?
- new words associated with maple time.
- Maple Syrup Cookbook

HEALTH

- boiling for sterilization - other methods of sterilizing
- meaning of purification - why?
- compare care of tree (i.e. tap hole, pill inserted to prevent infection) to care of cuts on the human body.

RECIPES

MAPLE TARTS

Rich pie crust

2 eggs
 170 ml - 190 ml maple syrup
 1.125 ml salt
 125 ml commercial sour cream
 - few drops vanilla
 125 ml chopped dates
 85 ml coarsely chopped walnuts
 - line 8 med. tart shells with pastry
 Beat eggs slightly and beat in syrup, salt, cream and vanilla
 Add dates and nuts
 Bake 177 degrees c for 25 minutes - makes 8 - Cost approx. 65¢

The Telegram
 March 1969

PIONEER BAKED BEANS

454 g pea beans
 Cold water
 114 g salt pork
 1 med. onion - halved
 65 ml White sugar (optional)
 5 - 7.5 ml salt
 5 ml dry mustard
 1.125 ml - 2.5 ml frshly ground pepper
 125 ml chili sauce
 250 ml dark maple syrup

Look over beans, removing any dark pieces. Cover well with cold water and soak overnight. In the morning, bring to boil in same liquid and simmer until skins start to crack - about 1- $\frac{1}{2}$ hours. At this point beans can be bitten, but are still crisp.

Drain, reserving liquid, and spread half in bean pot or heavy baking dish. Score rind of the pork with a sharp knife and place on beans. Add onion, then cover with remaining beans.

If you like beans quite sweet, add white sugar. Mix with salt, mustard, pepper, chili sauce, and 125 ml syrup. Pour over beans. Add bean liquid to cover, cover pot and bake at 121 degree C stirring occasionally for about 7 hours. Add water if needed.

Add remaining syrup and continue baking uncovered about 1 hour or until beans are tender. Makes 6-8 servings. Cost - Approximately \$1.00

The Telegram, March 1969.

VINEGAR

- usually made with sap gathered late in the season
- Sap is boiled down (3 litres of sap - 1 litre of vinegar)
- once the desired consistency has been obtained it is poured into bowls and allowed to ferment in a sunny place.

SUGARING

- 500 ml maple syrup in a heavy saucepan
 - moderate heat
 - stirring and watching carefully as it foams easily - until a few drops form a soft ball in cold water
(temperature of syrup - 113 - 114 degrees C)
 - cool until lukewarm
 - stir until mixture starts to lose its gloss and begins to thicken
 - spoon into tiny tart moulds or small pie plate
- Makes 12 small moulds.

MAPLE SAUCE

- 570 ml maple syrup
 - 65 ml butter
- Boil syrup and butter until it forms a thread when dropped from spoon.
Pour while hot over vanilla or lemon ice cream.

MAPLE NUT SAUCE

- Boil 250 ml maple syrup
125 ml 18% cream
until a soft ball is formed in cold water.
Beat 1 minute and then add 250 ml chopped nuts. Serve while hot.

PANCAKE RECIPE (used at Forest Valley)

First, mix these things together:

- 330 ml of flour
- 15 ml of baking powder
- 15 ml of sugar
- 2.5 ml of salt

Second, beat these things together:

- 1 egg
- 500 ml milk or buttermilk
- 30 ml oil

Then, slowly add the dry mix into the wet mix. Beat together until it is almost smooth. Now you are ready to fry the pancakes in a greased pan.

Pour on maple syrup to make the pancakes taste good. Makes about 12 pancakes.



MAPLE GLAZED CAKE

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Preheat oven to 177 degrees C
Grease a 25 cm tube pan and dust lightly with flour
Sift or blend together:
 750 ml pastry (soft wheat) flour
 12.5 ml baking powder
 2.5 ml salt
Cream - 250 ml butter
Blend in, beating until light and fluffy:
 500 ml granulated sugar
 10 ml maple flavouring
Add, one at a time, beating well after each addition:
 5 eggs
Stir dry ingredients into creamed mixture alternately with:
 170 ml milk
Make 3 dry and 2 liquid additions, combining lightly after each.
Turn into prepared pan.
Bake in 177 degree C oven for 60 to 65 minutes, or until cake
springs back when lightly touched. Cool 5 minutes and remove
from pan.
Bring to a boil and simmer to 112 degrees C on a candy thermometer
250 ml maple syrup - brush over warm cake.

MAPLE SYRUP BUNS

Pour 250 ml of milk into a large pot and add
 125 ml granulated sugar
 10 ml salt
 170 ml shortening
 250 ml mashed cooked potatoes (2 medium)
 250 ml all-purpose flour
 2 eggs, well beaten
 15 ml cinnamon

Heat and stir until shortening melts. Cool to lukewarm.

Meanwhile, dissolve 1 teaspoon sugar in 125 ml lukewarm water (38 degrees C.)
Over this sprinkle 1 envelope active dry yeast. Let stand for 10 minutes
then stir briskly with a fork.

Add softened yeast to lukewarm milk mixture. stir, cover with wax paper
and a damp cloth. Let stand in a warm place for 2 hours.

Cover 375 ml of raisins with boiling water; allow to plump, then drain.
Stir raisins into batter with 500 ml all-purpose flour.

Add another 500 ml all-purpose flour. Work in last of the flour with a
rotating motion of the hand. Turn dough out on a lightly floured surface
and knead 8 to 10 minutes.

Shape into a smooth ball and place in a greased bowl, rotating dough to grease.
Cover and let rise until doubled (about 2 hours.)

Roll dough out $1\frac{1}{2}$ cm thick and cut with a 5 cm cookie cutter. Place on greased
baking sheet. Cover and let rise 15 minutes. Bake in preheated 204 degrees C
oven for 15 to 18 minutes, or until light golden brown.

Boil together until it forms a thread (110 degree C on a candy thermometer)
 125 ml maple syrup - 15 ml granulated sugar

Drizzle on buns while they are still hot. Makes about 4 dozen buns.

MAPLE NUT CAKE

500 ml firmly packed brown sugar
500 ml sifted flour
5 ml baking powder
2.5 ml baking soda
2.5 ml salt

125 ml butter
125 ml chopped nuts
250 ml soured half-and-half
2 eggs
3.875 ml maple flavoring

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Mix together brown sugar, flour, baking powder, soda and salt in large bowl. Crumble butter and cut into flour mixture until mealy. Add chopped nuts. Mix well; reserve 250 ml of mixture for topping. Add soured half-and-half, eggs and maple flavoring to remaining flour-mixture. Mix well; pour into greased and floured 28 cm x 18 cm x 4 cm pan. Sprinkle reserved crumb mixture over top. Smooth with rubber spatula. Bake at 191 degrees C for 35 to 40 minutes.

MAPLE NUT CHIFFON CAKE

365 ml sifted cake flour
15 ml baking powder
190 ml brown sugar
5 egg yolks
10 ml maple flavoring
2.5 ml cream of tartar

190 ml granulated sugar
5 ml salt
125 ml salad oil
190 ml cold water
250 ml (8 eggs) egg whites
250 ml finely chopped walnuts

Sift flour, granulated sugar, baking powder, and salt into mixing bowl; stir in brown sugar. Make a well in dry ingredients. In this order, add: salad oil, egg yolks, water and flavoring. Beat until satin smooth.

Combine egg whites and cream of tartar in large mixing bowl. Beat until they form very stiff peaks (stiffer than for meringue or angel cake). Pour egg-yolk batter in thin stream over entire surface of egg whites, gently cutting and folding - down, across bottom, up the side, and over-just until blended. Fold in nuts. Bake in ungreased 25 centimetres tube pan in slow oven (163 degree C) 55 minutes; increase heat to 177 degree C and bake 10 to 15 minutes more. Invert pan; let cool thoroughly. Frost cooled cake.

MAPLE CREAM CAKE

Prepare a white cake batter. Flavour with 2.5 ml maple flavouring. Bake in layers. When cool, fill layers with Maple Cream Filling and frost with Maple Seven-Minute Frosting.

MAPLE SUGAR COOKIES

Preheat oven to 177 degree C. Grease baking sheet lightly.
Sift or blend together:

500 ml pastry (soft wheat) flour
1 teaspoon baking powder

Cream together:

250 ml butter
250 ml maple sugar
125 ml lightly packed brown sugar

Blend in:

1 egg
1 tablespoon water

Stir dry ingredients into creamed mixture. Roll dough out about 5 mm thick on a lightly floured surface and cut with a floured 7½ cm cookie cutter. Place about 2½ cm apart on prepared baking sheet. Bake in 177 degree C oven for 5 to 8 minutes, or until golden brown. Makes 6 dozen.

MAPLE TARTS

Prepare sufficient pastry to line 8 medium tart shells or muffin cups.

2 eggs	160 - 190 ml maple syrup
.125 ml salt	125 ml sour cream
few drops vanilla	85 ml coarsely chopped walnuts
125 ml chopped dates	

Beat eggs slightly and beat in syrup, salt, cream, and vanilla. Add dates and nuts. Bake in 177 degree C oven for 25 minutes. Makes eight tarts.

MAPLE FROSTING

190 ml maple syrup	65 ml white sugar
1 egg white, stiffly beaten	

Cook maple syrup and sugar together until it spins a thread. Pour this syrup over the stiffly beaten egg white beating constantly. Frost cake when icing is cool enough to keep it's shape. Yield: Enough for an 20 cm x 30 cm cake.

MAPLE SEVEN MINUTE FROSTING

190 ml hot maple syrup	.07 cream of tartar
10 ml granulated sugar	1 egg white, unbeaten

Combine hot maple syrup, cream of tartar and sugar in top of double boiler. Place over boiling water and add unbeaten egg white.

Beat with rotary or electric beater until thick and smooth. Remove from heat and use immediately. Yield: Enough for large layer cake.

MAPLE MARSHMALLOW FROSTING

250 ml maple sugar	125 ml boiling water
2 egg whites	6 marshmallows or 30 ml
2.5 ml vanilla	marshmallow cream

Cook the sugar and water together stirring until the sugar is dissolved. Then cook without stirring to the soft-ball stage 114 degrees C.

Add the marshmallow to the hot syrup pressing it under the surface so that it will melt. If marshmallow candies are used, cut into small pieces.

Pour the syrup in a thin stream to the stiffly beaten egg whites, beating the mixture constantly with a spoon, add vanilla. Cool before spreading.

MAPLE SYRUP ICING

85 ml maple syrup	45 ml butter
375 ml icing sugar, sifted	.07 ml salt

Cook syrup three minutes. Set aside to cool. Cream butter, add part of sugar gradually, then remaining sugar alternately with syrup, until of right consistency to spread. Add salt and beat well.

MAPLE FRUIT ICE CREAM

250 ml maple syrup	500 ml cream
125 ml candied cherries	250 ml crushed pineapple fresh or canned

combine all ingredients and freeze.

MAPLE NUT PUDDING

Mix 85 ml of cornstarch with 65 ml cold water. Add 125 ml of brown sugar and 500 ml of boiling water. Cook until thickened, then cook over boiling water for 2 minutes.

Add 3 stiffly beaten egg whites and 125 ml chopped nutmeats. Pour into moulds and chill. Serves 6 people.

MAPLE MOUSSE

190 ml maple syrup	4 egg yolks (Beaten)
.07 ml salt	5 ml vanilla
440 ml evaporated milk (Chilled)	

Combine maple syrup, egg yolks and salt. Cook over boiling water until thickened. Beat until cool. Add vanilla and chill. Whip milk very stiff, and fold in maple custard. Freeze until firm. Serves 6 to 8 people.

MAPLE PARFAIT

90 ml maple syrup	3 egg whites
570 ml of cream	

Cook maple syrup to the light crack stage 132 degrees C. Pour the syrup over the beaten egg whites and beat until cold. Fold into the stiffly beaten whipped cream. Mold and pack in ice and salt for four hours, or pack and freeze into the trays of the refrigerator. Serve in parfait glasses with whipped cream.

MAPLE ICE CREAM

250 ml rich maple syrup	4 yolks of eggs
570 ml cream, whipped	1 white of egg, whipped

Heat syrup to the boiling point and pour gradually on the well beaten yolks. Cook in double boiler, stir until custard coats spoon. Cool and add to cream and white of egg. Freeze.

MAPLE BAKED APPLES

Preheat oven to 177 degrees C. Wash and core 6 apples and peel them halfway down. Place apples in a shallow baking pan, and fill centres with 250 ml of seedless raisins. Combine 375 ml of maple flavoured syrup and 45 ml lemon juice, and pour into the raisin-filled centres. Add enough water around the apples to cover the bottom of the pan. Bake for 30 to 40 minutes, until apples are tender. Spoon the juices over the apple several times as they are baking. To serve, sprinkle lightly with maple sugar, or top each apple with a pressed maple sugar leaf.

MAPLE NUT PENOCHÉ

750 ml maple sugar	190 ml milk
30 ml butter	5 ml vanilla
500 ml chopped nuts	

Boil sugar and milk to the soft ball stage. Remove from the heat; add butter, flavouring and nuts. Cool. Beat until creamy and thickened. Pour into a greased tin and when firm, cut into squares.

MAPLE SNOW

Boil maple syrup to the soft ball stage (114 degrees C on a candy thermometer) and pour it over crushed ice.

MAPLE CREAMS

250 ml maple sugar	250 ml light brown sugar	
65 ml water	walnut meats	2.5 ml almond extract (Continued)

MAPLE CREAMS (Continued)

Cook the sugar and water to 115 degrees C or to the soft-ball stage. Add the almond extract. Cool to luke warm, then beat until creamy, yet firm. Knead until smooth, form into small balls and press a walnut meat into each.

MAPLE SUGAR

250 ml light brown sugar	5 ml vanilla
250 ml maple sugar	.125 ml salt
125 ml water	250 ml broken nut meats
30 ml butter	

Boil the sugar and water to the stiff-ball stage 119 degrees C. Add butter and cook to the brittle stage, 145 degrees C - 150 degrees C. Add the vanilla and salt and pour into a buttered pan, spreading very thin. Sprinkle with the chopped nut meats.

METRIC EQUIVALENTS FOR COMMON CANADIAN HOUSEHOLD MEASURESVOLUME

1 quart (40 fluid ounces)	1137 millilitres	1.14 litre
1 pint (20 fluid ounces)	568 millilitres	
1 cup (8 U.S. fluid ounces)*	237 millilitres	
1 tablespoon	15 millilitres	
1 teaspoon	5 millilitres	
1 fluid ounce	28.4 millilitres	

WEIGHT

1 pound	454 grams
1 ounce	28.3 grams

LENGTH

12 inches	30.5 centimetres
1 inch	2.54 centimetres

TEMPERATURE

F	C
450 -	232
425 -	218
400 -	204
375 -	191
350 -	177
325 -	163
300 -	149
212 -	100

OVEN TEMPERATURES

These will be recommended in metric cookbooks, but for those whose ranges have not been converted it is easy to remember: for oven temperatures only, the Celsius temperature is very close to half the Fahrenheit. A moderate oven, for example of 350 F should be set at about 175 C.

*Most measuring cups are in U.S. Fluid ounces

The following recipes have been converted to metric with the aid of the above chart.

N.B. Sometimes conversion to metric alters the recipe. The Forest Valley Staff has not tested the recipes in the metric form. Please be advised that some modification may be necessary.

S P E C I F I C
M A P L E
S Y R U P
A C T I V I T I E S

ALTHOUGH THE ACTIVITIES LISTED ON THE FOLLOWING PAGES ARE OUTLINED IN CONSIDERABLE DETAIL THE ACTIVITY SHOULD BE ADJUSTED TO SUIT THE INDIVIDUAL NEEDS AND ABILITIES OF THE STUDENTS IN YOUR CLASS.



ACTIVITY I - Trees in the Sugar Bush

PURPOSE: To aid the student in identifying different species of trees: i.e. maple, beech, poplar, wild cherry, or oak.

Teacher Background:

Tree Key

Beech

- Set up, use
- The beech trees have a speckled grey bark with a cement-like texture. Don't be misled by the greenish covering of moss.

Wild Cherry

- Deep brownish black bark - texture resembles potato chips glued to the tree.

Maple

- General - rough brownish bark on trunk and larger branches. Smaller branches are generally smooth and grey.

Red Maple

- Can be distinguished from the sugar maple by the following features:
 - a) reddish coloured buds in early spring
 - b) leaf shape in later spring and summer.



BLACK MAPLE



SUGAR MAPLE



RED MAPLE



SILVER MAPLE

- Leaves of the sugar maple (*Acer saccharum* Marsh) red maple (*A. rubrum* L.), silver maple (*A. saccharinum* L.), and black maple (*A. nigrum* Mischx. F.).

c) branch structure of tree. (see diagram)

Poplar

- yellowish grey bark, short branches. (see diagram)

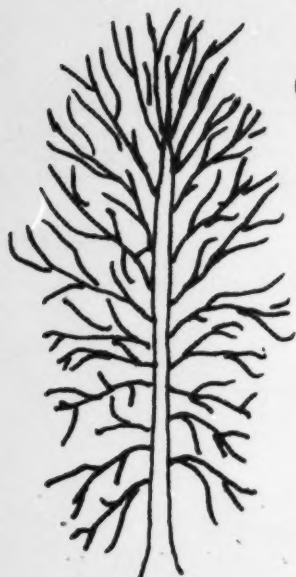
Oak

- Oak trees are much more difficult to identify and the best method seems to be to look for dead leaves on the tree.

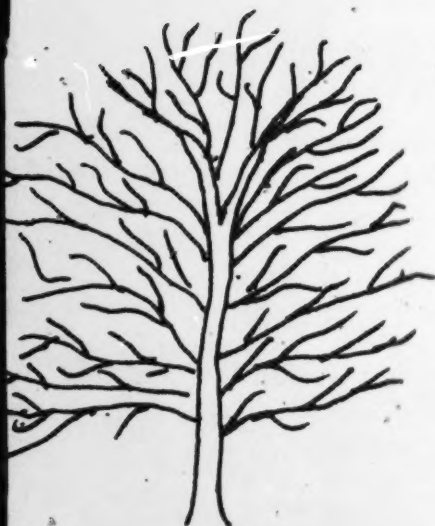
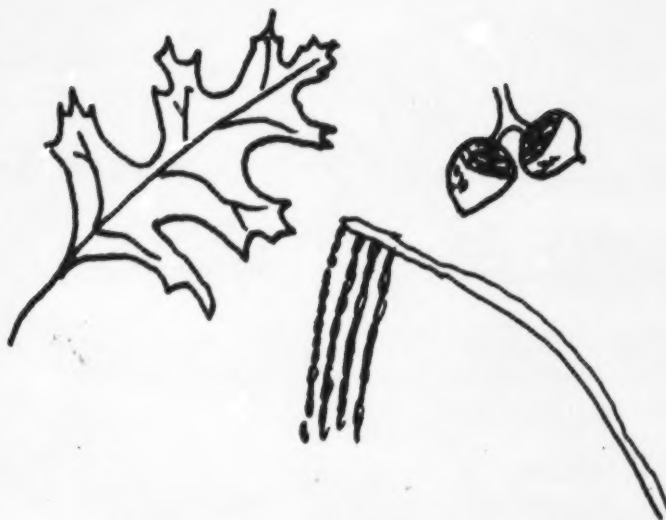
Classroom Preparation -

Little advanced preparation is needed for this study. Children should, however, be encouraged to dress warmly as for all field work. It might prove valuable to introduce the "tree key" to help

students classify information gathered on the trip.



OAK TREE



MAPLE TREE



Field Activities:

Introduce the children to each species of tree separately. Draw attention to the colour and texture of the bark, the colour and shape of the buds, and any other distinguishable features.

After the introduction of each tree, challenge the children to go and stand beside another tree of similar species on the immediate area. Coach the children by drawing their attention of noticeable features until relative accuracy in recognition has been gained by the children.

- Take the children on a short walk, and as trees being studied are met on the trail, pause and have them identified by the children. Use as little coaching as possible.
- Further competence in identification can be developed by:
 - a) Having the children count the number of a certain kind of tree in a marked-off area.
 - b) Have the children measure the circumference of certain species of trees with a tape measure.
- Trees other than the one suggested might also be included in the study. The main point being to insure accuracy in identification on the part of the children.

Additional Activities

1. Soil profile of the sugar bush noting the depth of the humus layer. Use a Sudbury Soil Testing Kit to determine the composition. Further work can be done in the area of soil production - what makes soil. supplies the nutrients, etc.
2. Map the sugar bush in relation to the drainage pattern. Do a vegetation profile (lowland to highland) and an accountability study (why trees grow where they do - i.e. maples on high ground - fir, cedar where drainage is poor).
3. Through research, the students could find other uses for the maple tree beyond the production of maple syrup.

ACTIVITY II - Selection of Maple Trees

PURPOSE: To measure the circumference (distance around) of trees. When provided with a table suggesting the number of tap holes that can safely be drilled into a maple tree of certain size, the student should be able to calculate the number of holes that can safely be drilled into the tree which he or she is studying.

When provided with the data of sugar maple tree circumferences, the student should be able to determine the number of pails and spiles which will be needed in the collecting of sap in the defined area of the sugar bush.

TEACHER BACKGROUND:

Selecting trees for tapping is of the greatest importance, and can be done at any time throughout the year. Trees are generally selected for the density of the sap produced, and the circumference of the tree. Over-tapping of a tree will kill it. Trees selected for tapping should have a minimum circumference of 75 cm at 135 centimetres from the ground.

The following table indicates the optimum number of tapholes that can safely be drilled into trees of various sizes.

Number of Tapholes	
Circumference of tree, Centimetres	Tapholes per tree, number
Less than 75 centimetres	0
75 - 90 "	1
91 -150 "	2
151 -185 "	3
Over 185 "	4

Classroom preparation: Review the five types of trees studied in Activity I.

Materials need - per 4 students - 1 table of tapholes - 1 tape measure

Field Activities:

- Mark off an area (quadrate) of a size convenient for study. Have the children measure the circumference of each of the maple trees in this defined area.
- Use the table in the teacher's background information to calculate the number of holes that can be drilled in each tree.
- Calculate the number of pails and spiles you would need to tap the area of study.

Additional Activities -

1. Estimate and compare the height of maple trees with other varieties. (Children will need to be introduced to the clinometer). The results can be graphically expressed.

ACTIVITY III - Tapping the Maple Tree

PURPOSE: To provide the student with the necessary skills to tap a maple tree successfully.

Tapholes are made by boring with either a 9 or 11 mm fast cutting wood bit.

Professional tappers use electric or power drills. However, for our work we will use a regular carpenter's brace and bit. The hole is bored into the tree, preferably at a downward pitch, especially if germicidal pellets are used in the tapholes.



The hole is bored 5 to 8 centimetres deep or until stained heartwood is reached.

The position of the first taphole is selected arbitrarily 25 cm away from old tapholes.

Avoid using old tapholes. The hole should be 60 - 90 cm above the ground, or if there is snow on the ground, as close as possible to this height.

Over the years a large number of sap spouts have been designed and used. Students might find this an interesting area for a library research assignment.

The spouts have a tapered shoulder so that, when they are driven into position in the taphole, they form a water-tight seal with the bark and outer sapwood.

When the taphole has been made, it is necessary to drive in a spile.

The spout or spile has three important functions;

1. It conveys the sap from the taphole to the container.
2. It either connects the plastic tubing to the taphole, or serves as a support on which to hang the sap bucket.
3. It keeps wild or stray bacteria from gaining access to the moist taphole.

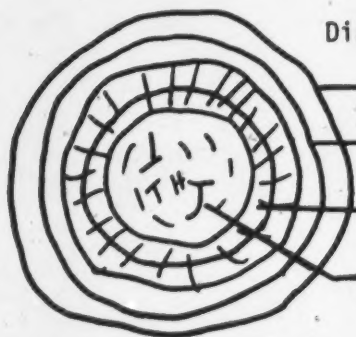


Diagram of a cross-section of a tree.

A. bark

B. cambium

C. sapwood

D. heart

Leave a free space between the sapwood and the spout. In setting the spout, care must be taken not to split the tree at the top and bottom of the taphole. A split results in sap leakage and all of the sap from that hole is dripped on the ground. Try to avoid striking the tree with the hammer as this often kills the tree for several inches around the bruise.

Classroom preparation:

Each detail in the background material should be taught before visiting the sugar bush.

Sample spiles, and wood cross-sections, if available, may be obtained from Forest Valley Outdoor Education Centre upon request.

Materials: per group of children

1 - spile 1 - carpenter's brace and bit 1 - sap pail 1 - hammer

Field Activities:

Students should be divided into groups of 5 or 6. Each group will then proceed to the tapping of a maple tree under the direction of a field assistant. Students should be encouraged to take part in the actual operation.

- Tapping of maple trees in the school yard, the collection of sap, and the making of syrup could be a worthwhile in-school activity. Avoid indiscriminate tapping.

ADDITIONAL ACTIVITIES

1. Research work on what other trees are tapped and for what purposes the sap is used.

ACTIVITY 4 - Sap Yield per Individual Taphole

PURPOSE: To determine the amount of sap produced from one taphole over a 24 hour period.

Teacher Background:

Specially graduated measuring sticks are used in this field investigation.

Each stick has been graduated to show the liquid volume of the sap in the pail in litres.

Classroom Preparation:

Illustrate the construction of a measuring stick by pouring a litre of water into a pail. Place an ungraduated stick into the water, and mark with a pencil at the top of the water line. Add another litre of water, and repeat the marking, by continuing with this process you will end up with a measuring stick which will show the quantity of the liquid.

Materials

- | | |
|----------------------------|---------------------|
| 1 - measuring stick | 1 - collecting pail |
| 1 - data sheet (see fig.A) | 1 - pencil |

Field Activities:

Each group of children will take a collecting pail, a measuring stick, and a data sheet with them to the sugar bush.

- Measure the amount of sap collected in the pail at each taphole. Record this information on your data sheet (see fig.A) and also on the chart affixed to the tree. When all measurements have been made, carefully pour the sap taken from the pail on the tree into your collecting pail.

***BE CAREFUL NOT TO SPILL THE SAP.**

- Take the collecting pail, filled with sap, to the large storage tank near the evaporator.
- If there is more than one spile on the tree, be sure to record the amount of sap collected from each spile on the appropriate chart on the tree.
- Calculate the total amount of sap produced per tree.
- Compare the amount of sap produced by each tree in your study area.
- Make a bar graph to illustrate your findings.

ACTIVITY V - Measuring the Rate of Sap Flow

PURPOSE: To calculate the rate of sap flow from a spile over a given period of time.

Teacher Background:

The sap flows very slowly from the tree, often a drop at a time. The rate of flow can thus be measured by counting the number of drops that flow per minute.

Materials - per groups of 4 or 5

1 stop watch
1 pencil

1 collecting pail
graph paper for each student

Classroom Preparation:

The idea of rate needs to be developed in the classroom before coming to the field. Rate is a measurement of distance or amount divided by the time required, e.g. if 15 drops of sap dripped from the spile in 1 minute, the rate would be 15 drops per minute; or if 15 drops of sap dropped from the spile in 3 minutes, the rate would be 15 divided by 3, or 5 drops per minute.

- The students should also be able to prepare a line graph to illustrate their findings.
- Averages should also be reviewed for this study.

Field Activities:

Count and record (see fig. C) the number of drops of sap flowing from the end of the spout in a minute period of time.

Repeat this process several times, and find an average.
What rate of flow did you find?

- Some problems for you to investigate:
 1. Does the sap flow at the same rate from each taphole in the tree?
 2. Does the sap flow at the same rate for each tree?
(Compare 5 trees, graph your results, (see fig. D).
- Use the information recorded on the tree. Compare the daily rate of flow of 5 such trees over the past week. Find your answer in pints per day.
- Compare (see fig. E) the sap flow each hour for an entire day. How did the flow differ?
- Compare the rate of sap flow early in the morning, and then later in the afternoon. What changes did you find? How would you explain these differences?

ACTIVITY VI - Sap Production and Tree Circumference

PURPOSE: To compare the amount of sap produced by two trees over a given period of time.

Class Preparation:

The class should review the measuring of circumference, and the various methods of measuring amounts of liquid.

Materials - per group of 4

1 tape measure
1 measuring stick
graph paper

1 collecting pail
1 data sheet (see fig. F)

Field Activities:

Measure and record the circumference of a minimum of ten trees in a designated area.

- Measure and record the total amount of sap produced by each tree that you

measured. If there is more than one taphole in a tree, divide the corrected total amount of sap by the number of holes, e.g. tree with tapholes - amt./3 (G)

MAKE SURE YOU RECORD THE SAP PRODUCTION ON THE CHART ON THE TREE.

- using the graph paper, compare the circumference of the tree and the amount of sap produced.

Some questions to answer:

- a) Did the circumference of the tree seem to affect the amount of sap produced?
- b) Which circumference produced the greatest amount of sap?
- If the amount of sap produced each day was constant, how much sap would each of these trees produce in 7 days?
- If the amount of sap produced each day was constant, how much sap would each of these trees produce in 7 days?

Tree A	25	centimetres - circumference
Tree B	90	" "
Tree C	150	" "

- If a grove has 5 trees of 150 cm circumference, 5 of 90 cm circumference, and 3 of 25 cm circumference, and the quantity of sap produced was constant with your findings today, how much sap would be produced in this grove in 5 days?

ADDITIONAL ACTIVITIES

Does the position of the spile (height, side of tree - i.e. north, south) affect the amount of sap collected in one day? Account for your findings.

What effect, if any, does the location or the tree have upon sap production? (i.e. a tree located deep within a sugar bush as compared to one located on the edge or in an open area)

What effect, if any, does the temperature and time of day have upon the amount of sap produced?

ACTIVITY VII - Sap Production and the Position of the Taphole

PURPOSE: To measure and compare the amount of sap produced from tapholes drilled at different heights.

Class Preparation:

Review methods of measuring the sap.

Materials - per group of 4 students

1 metre stick	1 collecting pail
1 measuring stick	

Field Activities:

Measure the heights (see fig. H) of a number of tapholes in the sugar bush.

- Measure and collect the sap from each pail.
- Record your information on a data sheet.
- Prepare a graph to illustrate your findings, and answer this question. "Does the height of the taphole above the ground affect the amount of sap produced?"

Some Additional Activities

1. Does the position of the taphole, (north, south) affect the amount of

sap production? (see fig. I)

2. Compare the shape of the tree and its ability to produce sap.
3. Compare the sap production of trees in a grove with those in an open area.
4. Compare the number of tapholes, and the sap production.
5. Compare the depth of the tapholes, and the amount of sap produced.
6. Suggest and try some other comparisons about sap production.

ACTIVITY VIII - Comparing Sap Production and the Weather

PURPOSE: To measure and compare the rate of sap flow, and compare it to the existing weather conditions, i.e. temperature, moisture, wind, speed, and direction.

Teacher Background:

Little is known at the present time about the exact conditions which trigger sap flow. The sap seems to flow any time from late fall after the leaves have fallen until well into the spring. Each time a period of below-freezing weather is followed by a period of warm weather sap is sure to run. A period of wet snowfall associated with mild temperatures also seems to promote sap production.

Thermometer - A standard Centigrade thermometer is used in all weather stations. Do not be concerned about conversion to Fahrenheit.

Anemometer - 1. Adjust the front dial to 0.
 - 2. Hold the anemometer at an arms distance from you 1 minute.
 - 3. Press the hold button at the end of the 1 minute and record your findings.
 - 4. To calculate the speed of the wind in km/h per hour multiply your answer by 60.

Humidity - A wet and dry bulb thermometer is used to calculate the % of humidity. Follow these steps in your calculations.

1. Read and record the temperature on both the wet and dry thermometer.
2. Subtract the wet reading from the dry reading.

e.g. Dry bulb 7 celsius
 Wet bulb 5 "
 Difference 2 "

3. Using the percent of relative Humidity Chart (Appendix D)

- a) read horizontally across the top line until you come to the number represented by the difference. e.g. 2 from above.
- b) read vertically down the left hand side until you come to the temperature of the dry bulb.
- c) at the intersection of these two columns, is the % humidity reading.

e.g. a difference of 2 C at 7 C dry bulb reading would give you a 61 reading.

PERCENT OF RELATIVE HUMIDITY (PERCENTAGE) °C
DIFFERENCE IN DEGREES BETWEEN
DRY BULB AND WET BULB

Temperature
of dry bulb
(°C)

Depression of the wet bulb (°C)

	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
50	94	89	84	79	74	70	65	61	57	53	46	40	33	28	22
45	94	88	83	78	73	68	63	59	55	51	42	35	28	22	16
40	93	88	82	77	71	65	61	56	52	47	38	31	23	16	10
35	93	87	80	75	68	62	57	52	47	42	33	24	16	8	
30	92	86	78	72	65	59	53	47	41	36	26	16	8		
25	91	84	76	69	61	54	47	41	35	29	17	6			
20	90	81	73	64	56	47	40	32	26	18	5				
15	89	79	68	59	49	39	30	21	12	4					
10	87	75	62	51	38	27	17	5							

Classroom Preparation:

The children should be taught how to use each of the weather instruments discussed in the teacher background material. The methods of measuring the rate of up flow should be reviewed.

Materials - weather instruments - provided in the weather station.

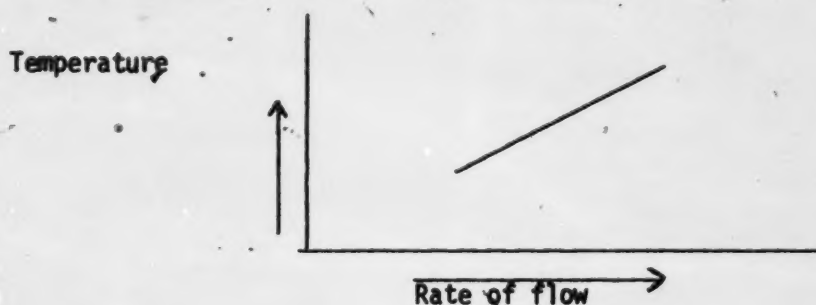
1 collecting pail - 1 stop watch - 1 measuring stick

Field Activities:

- Record the weather observations which you find at the weather station.
- Select a minimum of ten trees, and count the number of drops coming from each spile in a one minute period of time. Determine the average for each tree after you have made the measurement three times.
 - Use the data provided from the previous classes, (see fig. K) and compare the sap production under each varying weather condition. Do hourly rate sampling and make accurate temperature reading. Have thermometer on hand.

Some questions to answer:

1. Does weather seem to affect sap production?
 2. Which of the weather factors, temperature, moisture, or wind seem to affect sap production most dramatically?
- Compare the amount of sap production throughout the day with;
 - a) temperature changes
 - b) wind, speed, and direction.
 - Do some research in the library or write for information from your district forester on the factors which are used to determine when the best time is to begin tapping the maple trees.



ACTIVITY IX - Sugar Content of Maple Sap

PURPOSE: To measure the sugar content of the maple sap collected using a hydrometer.

Teacher Background: Hydrometry Method

Hydrometry is the most generally used method of measuring the density of the cold syrup, and it is best suited for use by the syrup maker. All that is required to make precise density measurements is a relatively inexpensive but accurate hydrometer, a thermometer, and a hydrometer tube or jar.

Hydrometry is based on the Archimedes principle that the density of a liquid can be measured by the displacement of a floating body. The hydrometer, a partly immersed body, displaces a volume of liquid having a mass equal to the weight of the hydrometer. A hydrometric measurement is made by noting the point on the hydrometer stem that is in contact with the surface of the liquid. The hydrometer must be at rest and floating freely in the liquid as shown in the diagram. The density value is read from a scale sealed in the stem. Various types of measurements can be made, however, for our studies the Brix scale will be used.

BRIX SCALE

The brix scale relates the density of syrup to sugar solutions of the same density and known percentages of sugar. The Brix value does not express the true percentage of sugar, in a solution containing sugar plus other dissolved solids; rather it expresses what the percentage of sugar would be if the density of the solution were due only to dissolved sugar. The Brix scale is particularly well suited for measuring the density of maple syrup because 98% of the dissolved solids is sugar. For practical purposes, the Brix value equals the percentage of sugar in the syrup. A good approximation of the weight of sugar in any lot of maple syrup, whether or not it is standard-density syrup, can be found by multiplying the mass of the syrup by its density. (degrees Brix) and dividing by 100. Thus, 100 kilograms of syrup at 64 Brix contains 64 kilograms of sugar.

Classroom Preparation:

Reading of the Hydrometer, and its use should be studied before classes begin their field work. Instruction in this technique can be provided by one of the resource personnel.

Discuss with the class the importance of knowing the sugar content of the sap. Have a sample of sugar solution of a known strength available.

Materials:

- 1 hydrometer
- 1 thermometer
- 1 hydrometer tube — make tube large enough in diameter so that hydro will float free.

Field Activities:

Fill the hydrometer tube about 1/4 full of maple sap. Take care not to spill the sap. Place your hydrometer into the sap. Make sure the tube is filled to the line before making the reading. Allow the hydrometer to float freely in the liquid, then take your reading. Observe the diagram below for the correct method of reading your hydrometer. The density value is read from the scale sealed into the stem.

Further Activities:

- Determine the sugar content of the sap of several different maple trees in the sugar bush.
- Compare the sugar content of the sap from different tapholes in various positions on the tree.
- Does the length of the sap run influence in any way the sugar content of the sap?
- Study the sugar content of the sap under differing weather conditions.
- Compare the sugar content of other trees, such as the beech, the poplar, etc., with the sugar maple.
- Compare the sugar content of maple trees with a good sized crown and one with a small crown.

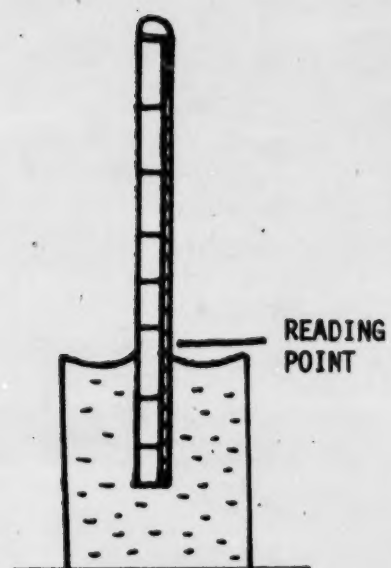
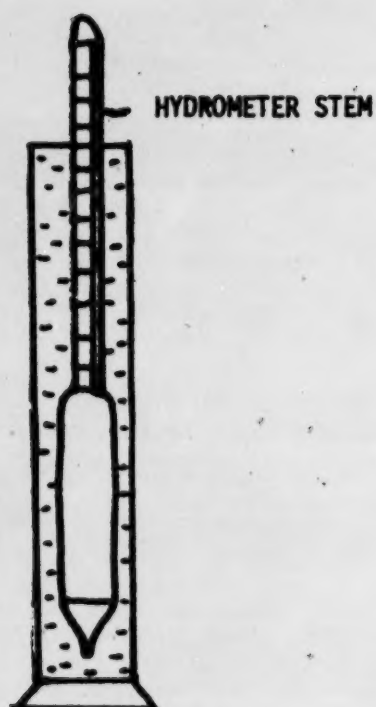


Chart 19. - Hydrometer used for measuring density.
The hydrometer can should be filled to the top.
It should be held at eye level for reading.

ACTIVITY X - Changes in Sap during Evaporation

PURPOSE: To observe the operation of a maple syrup evaporator and:

- a) measure with a colorimeter, the colour changes which take place in the maple sap while the evaporation process is proceeding.
- b) measure with a hydrometer, the density change that takes place in the sap as evaporation progresses.

Teacher Background:

Colour and Flavour

Maple sap as it comes from the tree is a sterile, crystal-clear liquid with a sweet taste. None of the brown color or flavour that we associate with maple syrup is in the sap. The typical colour and flavor of maple syrup are the result of chemical reactions, involving certain substances in the sap, brought about by heat as the sap boils. Since at least one of the products of the reaction is the brown color, it is known as the browning reaction. Neither the exact nature of this reaction nor the identity of the reacting substance is known. The colour of the syrup is dependent upon the boiling time, the darker syrup, the longer boiling time; and, conversely the shorter the boiling time the lighter the syrup.

Classroom Preparation:

Illustrate and discuss the role of the evaporator in the making of maple syrup.

Review the use of a colorimeter, and the hydrometer.

Field Activities:

Compare the colour of the sap as it comes from the tree, several times throughout the evaporating process. How does the color change:

- Taste a small sample of sap from each of the test locations from which you examined the color. Did you find any change? What changes did you note in the taste of the sap?
- Compare the taste of the syrup from the sugar maple and the red maple. Describe the difference in taste.
- Measure the density of the sap in each location using a hydrometer. What differences did you note? What do these different readings tell you about the thickness of the sap? How do you explain this difference?
- Measure the density of the sap, beginning with the sap from the tree, and then every 30 minutes until the syrup has been made. Record your findings as a line graph, and then analyze your data and try to explain how the sap changes during the evaporation process.
- Study the change in the pH of sap as it passes through the evaporators.

ACTIVITY XI - Measuring Water Content of Sap

PURPOSE: To measure and calculate the volume of water that can be evaporated from a measured sample of maple sap.

Teacher Background:

The water content of maple sap varies considerably from tree to tree. One taphole often produces from 200 to 400 litres of sap in a single year and when water has been evaporated will produce the equivalent of 5 to 10 litres of syrup. A conservative estimate is that the sap from four tapholes will yield 5 litres of syrup. This sap will likely have a density of 2.2 Brix. Thus, 40 litres of sap would yield 1 litre of syrup. The water content is measured and calculated from data collected with the hydrometer.

Classroom Preparation:

- Teach the application of "Rule 86" as given in the teacher background material.
- Review the use of the hydrometer in measuring sap density.

Field Activities:

- Calculate the amount of water which must be evaporated from a pail of sap which has been collected to make one litre of syrup.
- Compare the amount of water which must be evaporated from a pail of sap collected for a moist area and a dry area.
 - Is the water content of the sap influenced by changes of temperature, rain or snow fall, or by the wind speed?

Teacher Background:

The amount of water that must be removed to reduce the sap to syrup varies with the solids concentration of the sap. The "Rule of 86" can be applied to determine the number of litres of a particular sap required to produce 1 litre of standard-density syrup (65.5 Brix). Standard density syrup contains 86.3% of solids (as sugar on a mass volume basis). Since the solids concentration of sap is comparatively low, its Brix value and percentage of solids (Mass volume) are essentially the same. Therefore, the percentage of solids (mass volume) of the syrup divided by the Brix value of the sap equals the number of litres of sap required to produce one litre of syrup. In practice, the value of 86 can be used rather than 86.3 and the equation is:

$$a = \frac{86}{X}$$

where a the number of litres of water that must be removed from sap to produce one litre of standard-density syrup.

X the Brix value of the sap (to represent the solids concentration of the sap).

From this number, 1 is subtracted to obtain the number of litres of water that must be evaporated from the sap to obtain 1 litre of syrup. The following equation is used:

$$a = \frac{86}{X} - 1$$

Example: With sap having a density of 2.4 Brix, $a = \frac{86}{X} - 1$, or $36 - 1 = 35$,

The number of litres of water that must be evaporated to obtain one litre of standard density syrup.

ACTIVITY XII - A study of Microbial Growth

PURPOSE: To collect and grow some of the micro-organisms found associated with maple syrup making and to experiment to determine some of the conditions which will promote the growth of these organisms.

Teacher Background:

Micro-organisms readily grow in the sweet sap of the maple tree when temperature and other weather factors are right. These micro-organisms can be found growing in the tapholes, in the pails and collecting tubes, and in the sap itself. Most standard density saps, however, will not support active growth of the micro-organisms with the exception of a few types of yeast, and one or two types of bacteria. These organisms are generally destroyed by heating the syrup to at least 180°F., before packaging. Other spores of yeast, mold, or bacteria that may have gained access to the syrup while packaging will not be destroyed by this process, but will not grow unless conditions become favourable.

Micro-organisms are destroyed in the tapholes of the maple tree with a germicidal pellet, and collecting pails and tubes are sterilized with a special cleaning fluid.

Some of these micro-organisms will grow on a Potato dextrose agar media.

Materials: per group of 4

3 sterile test tubes containing an agar media	3 corks
sterile cotton swabs	potato dextrose agar
masking tape	

Classroom Preparation:

Prepare the test tubes of sterile potato dextrose agar. Sterilize a large number of cotton swabs, or Q - tips. Provide instruction on the method of transplanting micro-organisms from the area being studied to the agar media.

Field Activities:

Experiment with samples of sap at various places along the syrup production line to determine the ability of the sap to support micro-organisms. Use sterilized, labelled test tubes, (boiled in water for 15 minutes). Place about 5cc of sap into each test tube, cork and observe the time required for the micro-organisms to grow on the sap.

- Compare the amount of mold growth in various tapholes.
- Using small test tube samples of sap, compare the ability of micro-organisms to grow under varying environmental conditions, e.g. temperature, light, etc.
- Germicidal pellets are used to prevent the growth of micro-organisms in tapholes. Do they effectively control the growth of these harmful organisms? Try to find the answer by experimentation.

Additional Activities:

Through research the students can discover what diseases, insects, etc., that affect the health of a maple tree.

ACTIVITY XIII - Storage Tanks

PURPOSE: To measure, and calculate the volume of a storage tank, as well as determine suitable places for the erection of the tank in a sugar bush.

Teacher Background:

These problems are of a larger scale, and should be well discussed and planned before beginning the studies.

Materials: measuring and mapping materials

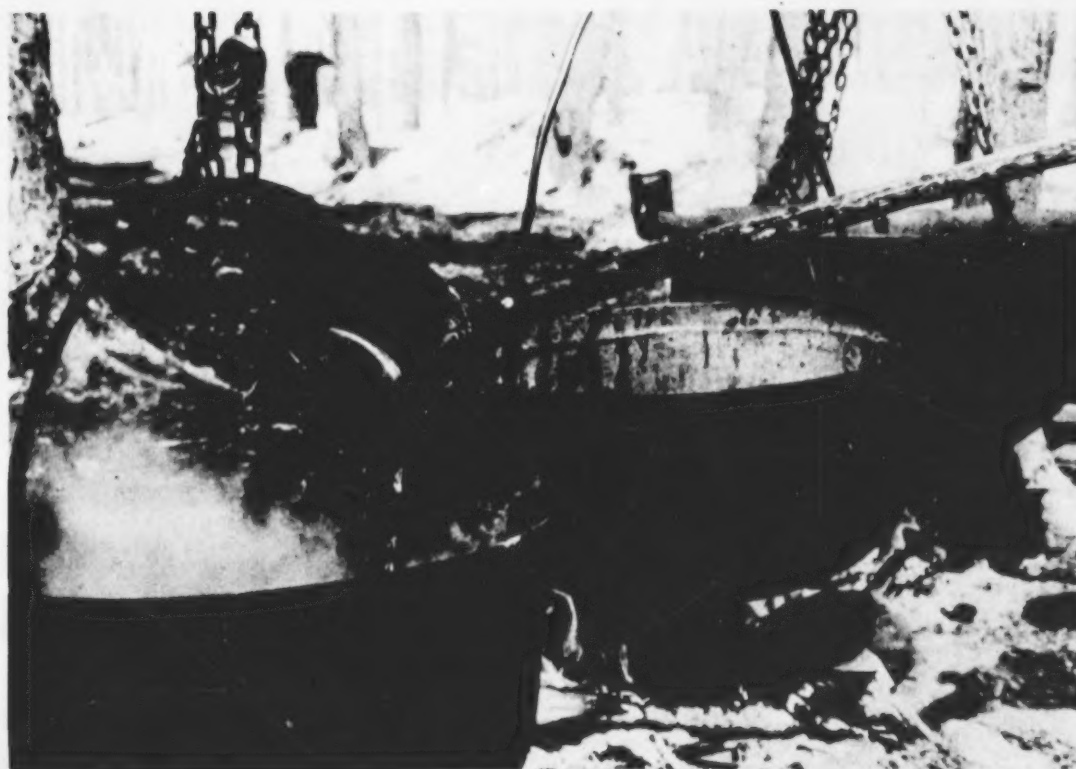
Classroom Preparation:

Develop the concepts of volume, and the methods of measuring volume.

Have the students design problems which they would like to conduct as independent investigations.

Field Activities:

- Calculate the volume of the storage tank in the sugar bush.
- Storage tanks can be filled and emptied by gravity.
Collect data, and study the sugar bush to determine the most suited place for the setting up of the tank.
- Study the sap production of a sugar bush, and calculate the volume of the storage tank that would be needed to hold the maximum daily sap produced. (Tanks must be large enough to hold the maximum daily sap production.)
- Storage tanks should be located in a cool place, and not inside the warm evaporator house. Study the temperatures of various locations in the sugar bush, and indicate on a map, the best location for the storage tank.



Graphs and Charts

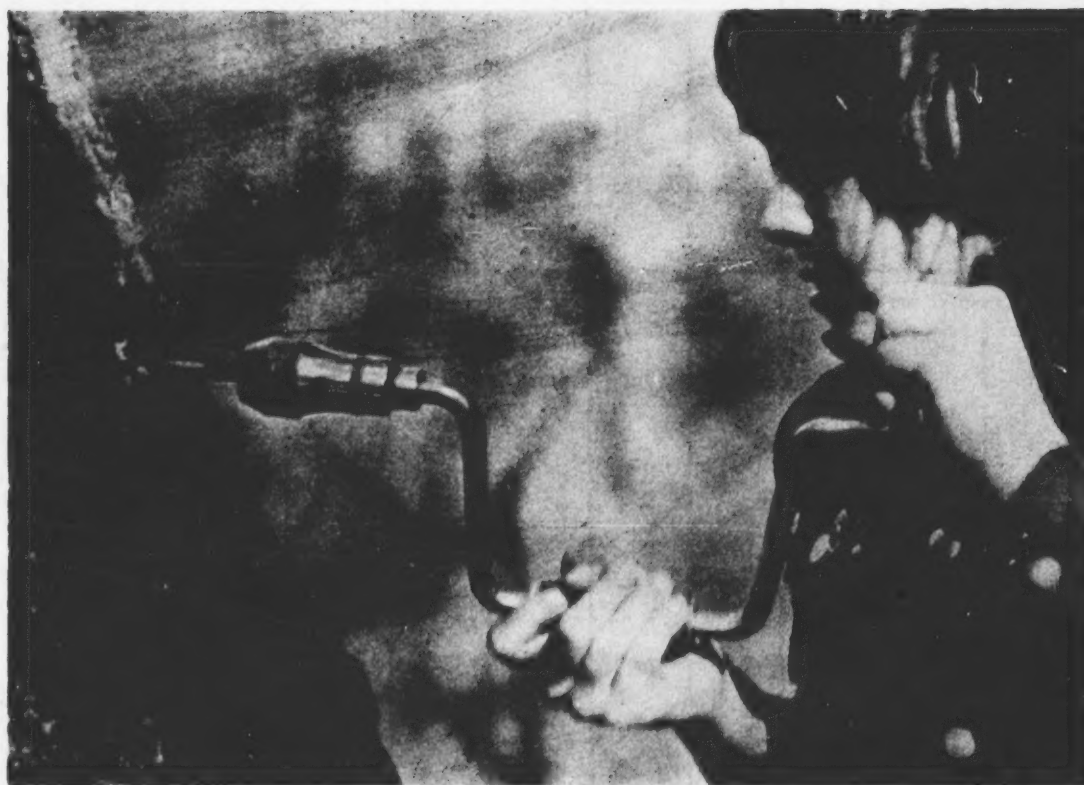


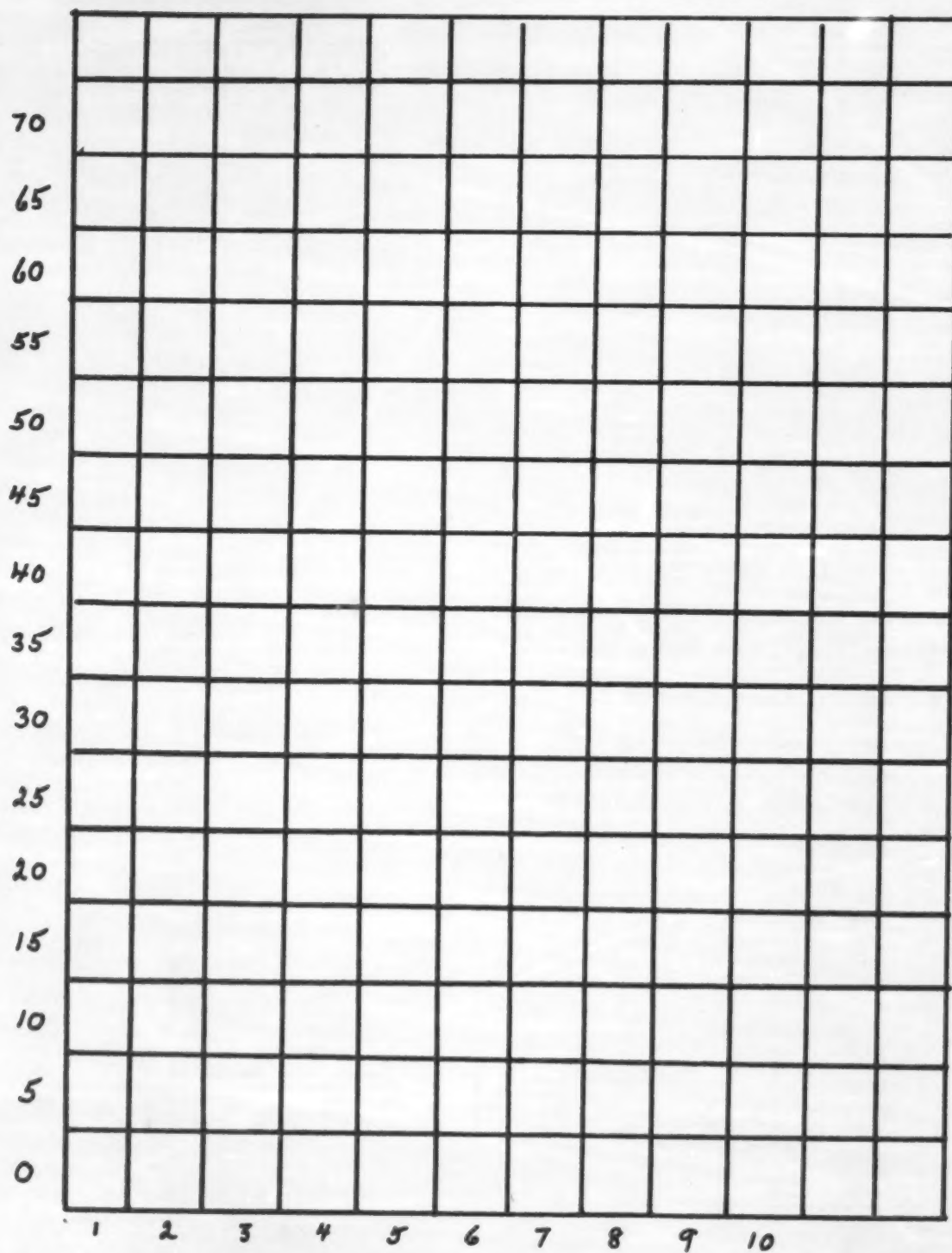
Fig. A

QUANTITY OF SAP COLLECTED

ACTIVITY NO IV

TREE NUMBER	QUANTITY OF SAP COLLECTED IN LITRES
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Comparison of sap production per tree



QUANTITY
of
SAP IN
Litres.

Tree Numbers

Fig. B

Fig. C

COMPARISON OF RATE OF SAP FLOW					39
TREE NUMBER	RATE OF SAP FLOW (Drops/min.)				
	Trial 1	Trial 2	Trial 3	Average	
1					
2					
3					
4					
5					

COMPARISON OF THE SAP FLOW
FROM 5 MAPLE TREES

R					
A					
T					
E					
O					
F					
S					
A					
P					
F					
L					
O					
W					
drops/	1	2	3	4	5
min					

Fig. E

COMPARISON OF SAP FLOW PER HOUR

TIME: HOUR OF THE DAY	RATE OF SAP FLOW IN DROPS PER MINUTE			
	TRIAL 1	TRIAL 2	TRIAL 3	AVERAGE

Fig. F

COMPARISON OF CIRCUMFERENCE OF MAPLE TREE
AND THE AMOUNT OF SAP PRODUCED

TREE NUMBER	CIRCUMFERENCE OF TREE IN CM	AMOUNT OF SAP PRODUCED IN litres/SPILE	TIME
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Fig. G

COMPARISON OF CIRCUMFERENCE AND SAP PRODUCTION

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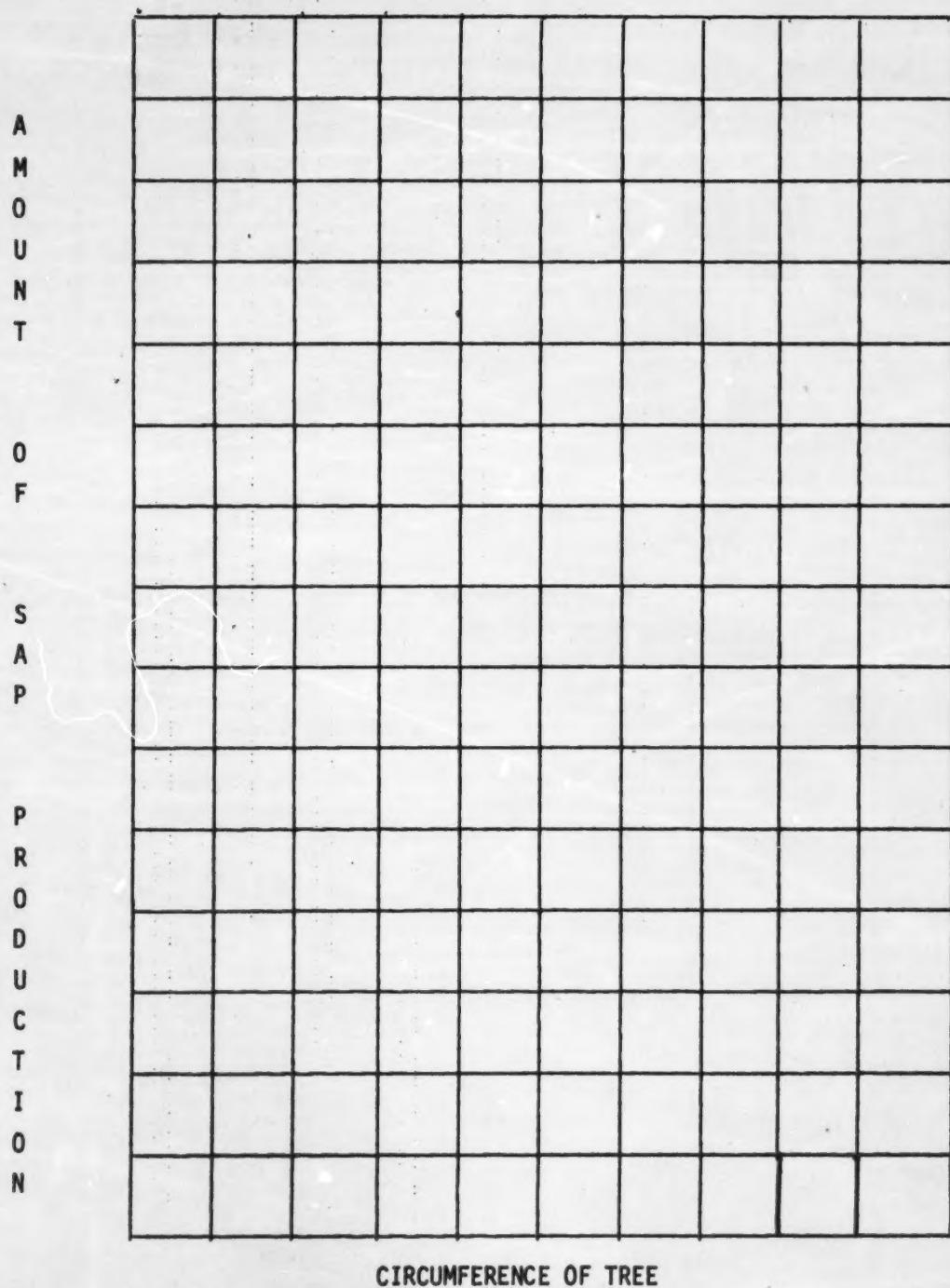


Fig. H

HEIGHT OF TAPHOLE AND
RATE OF FLOW DROPS/MIN.

HEIGHT OF TAPHOLE IN Centimetres	RATE OF SAP FLOW - RATE OF FLOW			
	TRIAL 1	TRIAL 2	TRIAL 3	AVERAGE

COMPARISON OF SAP FLOW AND
THE POSITION OF THE TAPHOLE

DIRECTION OF TAPHOLE	RATE OF SAP FLOW DROPS/MIN.			
	TRIAL 1	TRIAL 2	TRIAL 3	AVERAGE

Fig. I

Fig. J

NUMBER OF DRIPS PER MINUTE PER TREE

WEATHER CONDITIONS	1	2	3	4	5	AVERAGE
Temperature _____°C.						
Humidity _____%						
Wind Speed _____km/h						

DATE	TEMP.	HUMIDITY	SUNLIGHT	WIND SPEED	AVERAGE NO. DRIPS PER MIN.

Fig. K

QUESTIONS ON THE
MAPLE-SUGAR INDUSTRY

1. Who wrote the following:
 "I wonder if the sap is stirring yet,
 If frozen snowdrops feel as yet the sun.
 I am still sore in doubt concerning spring."
2. Anyone going to the "sugar bush" ought to be versed in "sugar-bush" parlance. What do the following terms mean: "treacle", "first run", "season", "stone boat", "caldron kettles", "sugar off"?
3. When was maple sugar a necessity, and when did it become a luxury?
4. What is the real sugar tree?
5. What part of the tree is the sugar factory?
6. How much maple sugar is made in Europe?
7. For what purpose do they use the ax in the maple-sugar camp?
8. What is ideal maple-sugar weather?
9. What are two distinguishing characteristics of maple-sugar buds?
10. What is the purpose of maple sugar?
11. Of what material was the sap spout of the Indian days? To-day?
12. Does the tapping of the tree leave a wound that will usually be infected by fungi?
13. What was the Indian method of concentrating the sugar?
14. What is the longest tapping season?
15. From what direction does the sap come?
16. On what side of the tree does the sap flow first?
17. What causes the sap to flow?
18. Name four animals (other than man) that have discovered that maple sap is good.
19. What were the earliest vessels for collecting maple sap?
20. About how much sap is required to make one litre of syrup?
21. What should be the size and position of the hole for sap flow?
22. Through what part or parts of the tree does sap flow?
23. What is the purpose of a "neck yoke"?
24. What is the advantage of locating a sugar house on a slope?
25. Why is skimming necessary?
26. How is the "evaporator" prevented from boiling over?
27. How many grams should maple syrup mass to the standard litre?
28. If a utensil has a full litre when the liquid is hot, will it be a full litre when cold? Why?
29. Why did "sugaring off" always occur at night in colonial times?

30. From what maples can sugar be made?
31. How is "maple wax" made?
32. What is often used to adulterate maple sugar?
33. How is the sugar separated from the water in sugar making?
34. What were the 3 commonest articles of barter of our forefathers?
35. How much sugar will a sugar-maple tree yield in one season?
36. What causes maple syrup to crystallize?
37. How can the concentration of the syrup be told by a thermometer?
38. What other instrument is often used to determine the density of the liquid?
39. Why is the "evaporator" made of metal?
40. Why did the cane and beet sugar take the place of maple sugar?
41. Why will the maple-sugar industry probably not pass into the hands of a corporation?
42. Which comes first in the sugar maple - the flowers or leaves?
43. What causes the sap to ferment?
44. Why does fruiting cause the sugar maple and not the red maple to fork at the twigs?
45. What causes "birds'-eye" maple?
46. Is maple sugar a confection or a food?
47. What is the maple-tree borer?

ANSWERS TO QUESTIONS ON THE

MAPLE-SUGAR INDUSTRY

1. Christina C. Rossetti in "The First Spring Day".
2. "Treacle" is the syrup drained from sugar in refining. "First run" is the first few weeks that the sap is flowing. "Stone boat" is the sled that is drawn by horses or oxen to bring in the sap to the sugar house. "Caldron kettles" are the large iron kettles in which the sap was formerly boiled down. "Sugar off" is the changing of the thick syrup to sugar.
3. In colonial times, maple sugar was considered a necessity. It is now a luxury.
4. The honey locust bean has 20 percent sugar, and the sap of the sugar maple is from 3 to 6 percent sugar.
5. The leaves are the factories where starch and sugar are manufactured.
6. Maple sugar is an American product. It is not made in Europe.
7. The ax is used to cut firewood and not to scar the trees.
8. Thawing days and freezing nights.
9. Compared with other maples they have sharp-pointed buds and many buds.
10. To make new leaves and wood.
11. The Indians made the sap spout from sumac or elder stems. They are now made of galvanized metal.
12. The wounds made by the tapper usually heal in one season and are not infected.
13. The Indian dropped hot stones into the sap.
14. Three to four weeks.
15. The sap comes from all parts of the tree. If you break a twig it will "bleed". Sap comes from above and from below. During the first part of the season, more comes from below than from above.
16. South.
17. When the tree is warmed, the air in the cell spaces expands.
18. Sapsucker, porcupine, red squirrel, insects (flies and bees).
19. Bark vessels and hollowed logs.
20. 40 litres
21. 1 cm hole, 5 cm deep; breast high, slanting up.
22. Up the sapwood and down the inner bark.
23. For individuals to carry pails of sap to the kettle to be "boiled down". It is a piece of wood that goes across the shoulders to hold a pail on each end.
24. So that one can use a siphon and run the sap by gravity.

25. To remove impurities such as bits of ashes, bark, etc.
26. By putting in cream, lard, or salt pork to break the surface tension of the foam.
27. Eleven.
28. Hot liquids contract when cooled.
29. They had to attend to sap buckets in the day.
30. Although the sugar maple makes the best sugar, it is also made from the red and silver maples.
31. By pouring dribblets of thick syrup on clean snow.
32. Brown sugar, because it is cheaper. Sometimes glucose.
33. By evaporation.
34. Furs, corn, and maple sugar.
35. .5 to 3 kilograms.
36. It concentrates to the point where it is no longer soluble in the water present.
37. The boiling point of a liquid varies with the altitude and also concentration.
38. A hydrometer, usually the Baume.
39. Conductor of heat that is necessary for evaporation.
40. Lower priced, steady supply, and modern machinery for refining.
41. Trees are scattered and mostly hand labor.
42. The flowers and leaves appear at the same time in the sugar maple.
43. Bacteria.
44. The fruit comes from end buds in the sugar maple and from side buds in the red maple.
45. The cause of birds'-eye and curly maple is unknown. It is not due to woodpeckers.
46. Although once thought of as food, it is now considered a confection.
47. The maple-tree borer is the grub of a beetle.